Science Impact of MODIS Calibration Degradation and C6+ Improvements

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Special thanks to MODAPS for CEOS desert sites subsets

MODIS Science Team Meeting
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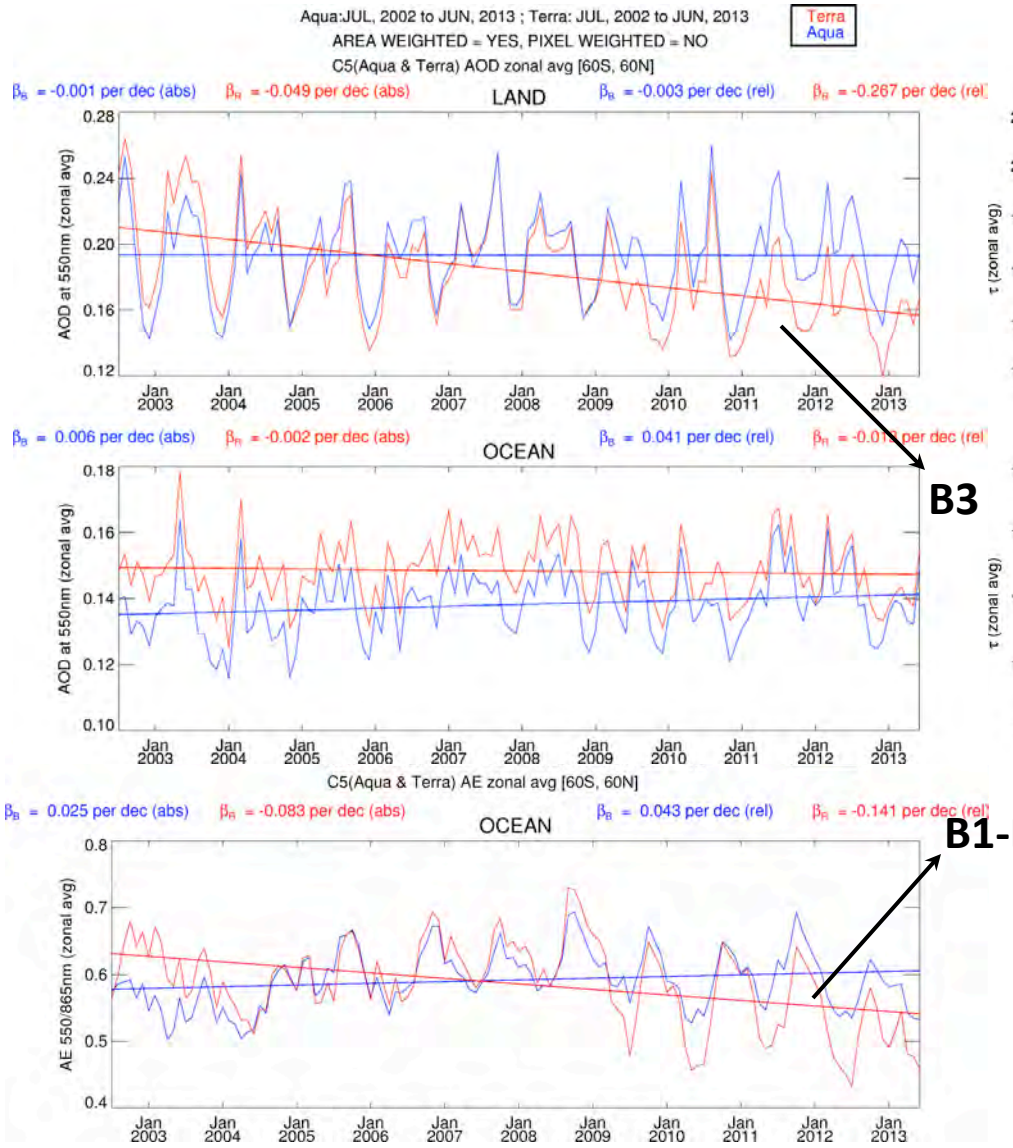
C5 Trends: Aerosol and Clouds

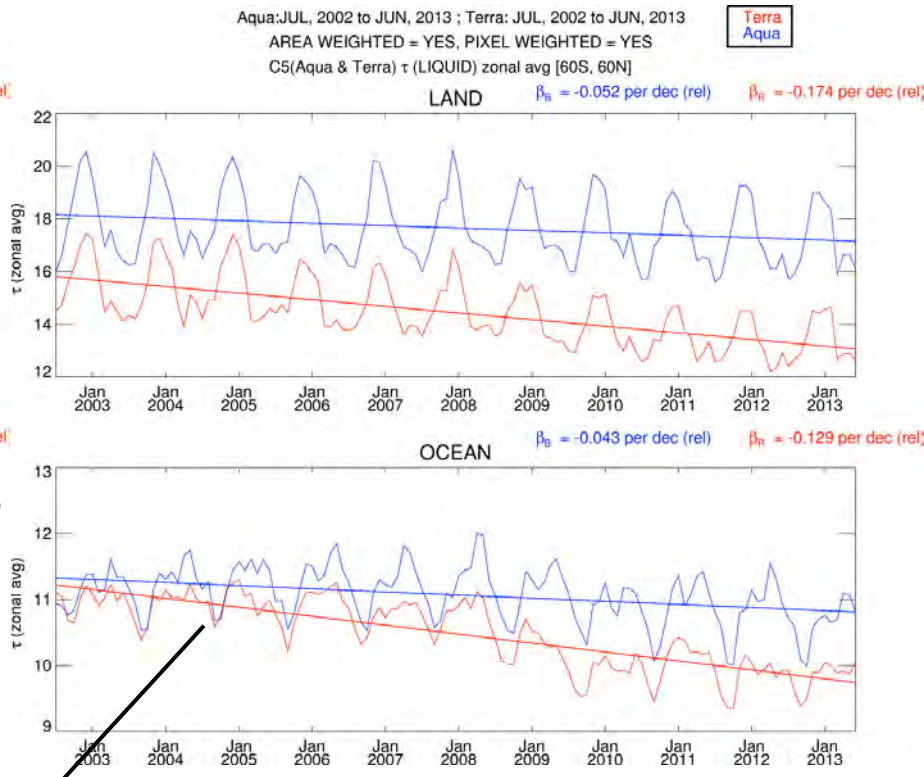
DT Aerosol: AOD and AE (R. Levy)



B3

B1-B2

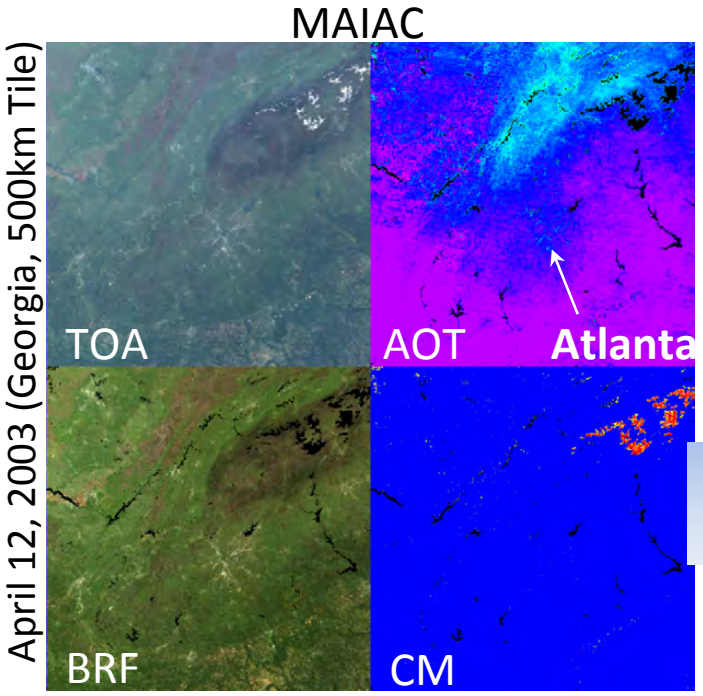
Cloud Opt. Properties: COT (S. Platnick)



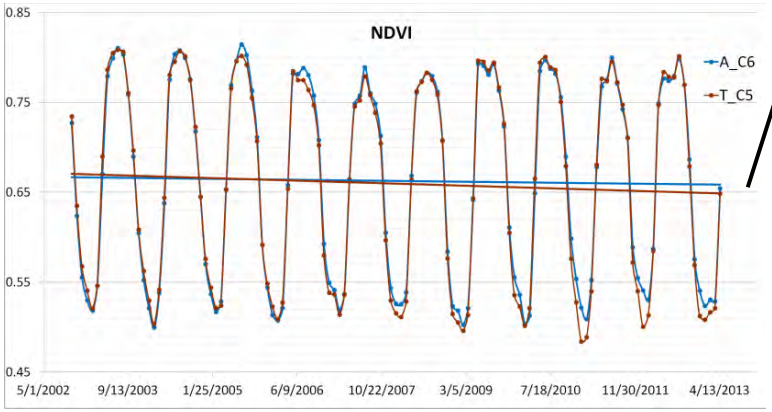
Levy et al. (2010), Global evaluation of the Collection 5 MODIS dark-target aerosol products over land, ACP.

Koukouli et al. (2010), Signs of a negative trend in the MODIS aerosol optical depth over the Southern Balkans, Atm. Environ.

C5 Trends: Land

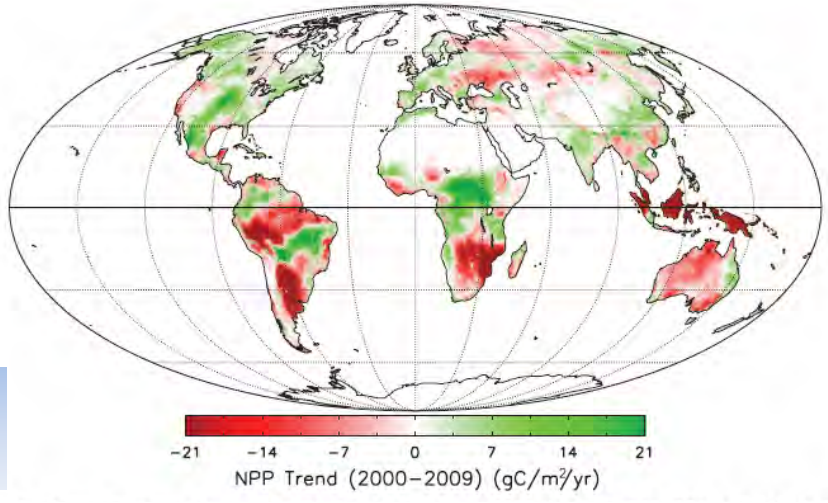


ΔNDVI=0.01 ~ 1 PgC GPP

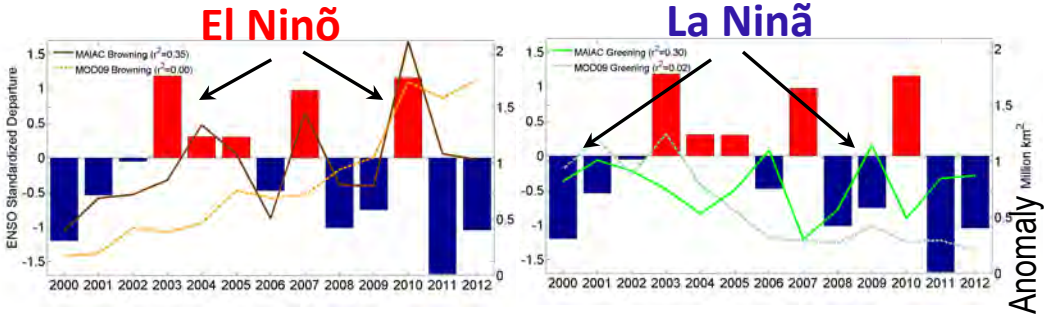


Wang, Morton et al. (2012), Impact of sensor degradation on the MODIS NDVI time series, RSE.

Zhao & Running (2010) *Science*, 329, 940-943.



- Reported NPP decrease of 0.55 PgC/decade;
- Tropics: 91% of global NPP var. (Amazon: 61%);



Amazon Browning and Greening Anomalies from MOD09 C5 (dashed) and MAIAC C6 L1B data (solid).

Anomaly Analysis – Myneni & Jian (BU)
Correlation with MEI – Hilker & Lyapustin

Polarization Sensitivity of MODIS Terra

-Part of nadir aperture door was overheated during TVC;
- May 2003 anomaly: SD diffuser door permanently open, SD screen closed.
- 2008, Franz et al.: OBPG reports Terra pol. sensitivity and develops correction algorithm (Meister et al., 2005; 2012; Kwiatkowska et al.:2008).

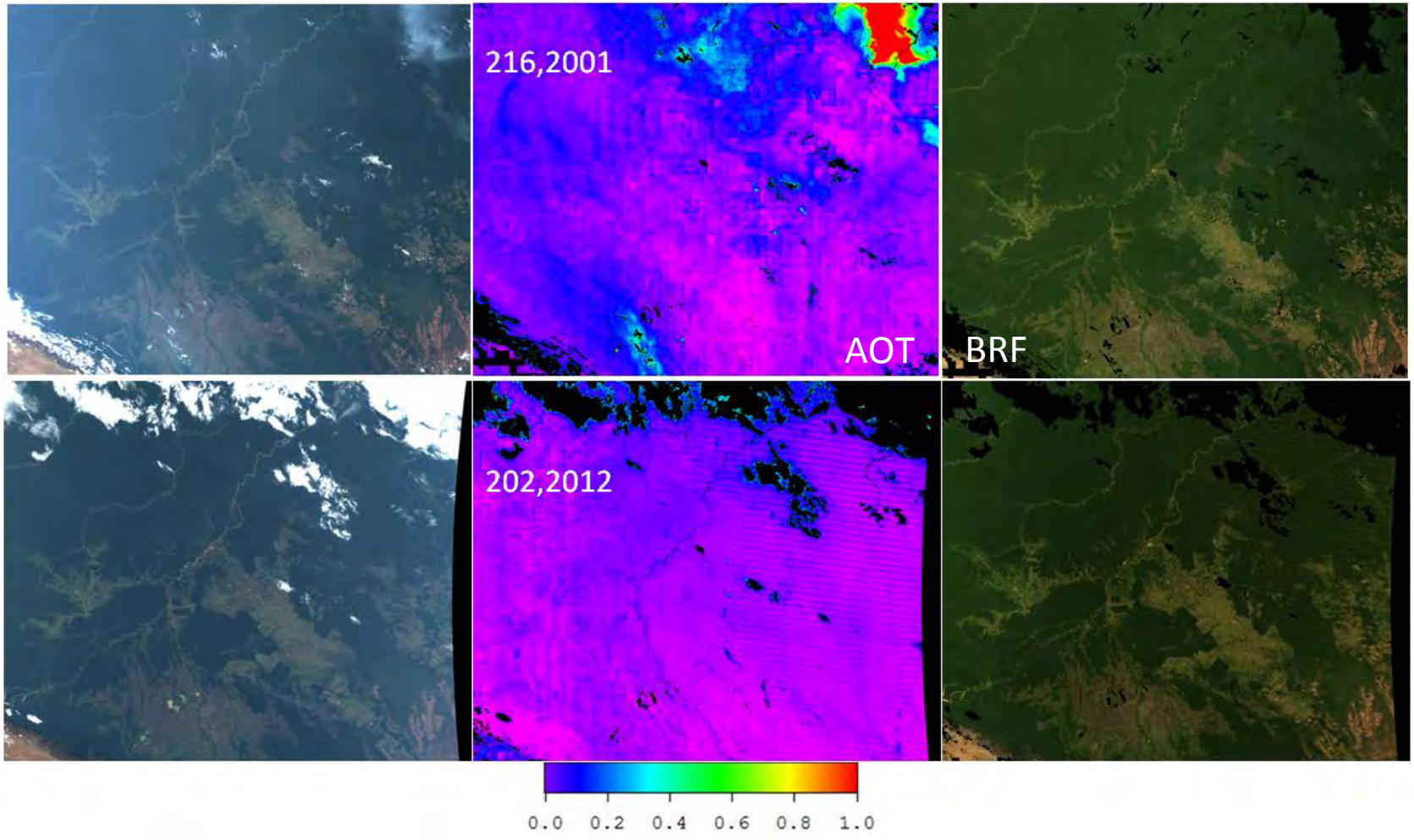


Illustration of MODIS Terra MS difference & polarization sensitivity with MAIAC (10km striping).

Polarization Correction: Terra-Aqua Xcal
(algorithm developed by the ocean color team)

$$L_m/M_{11} = L_t + m_{12}*Q + m_{13}*U$$

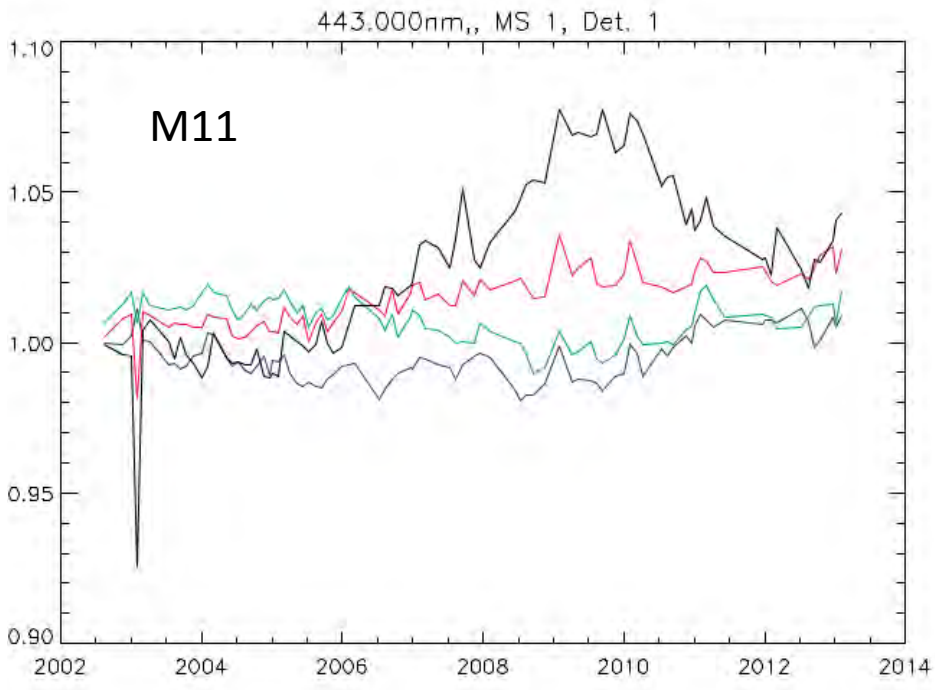
L_m: measured TOA radiance (Terra)

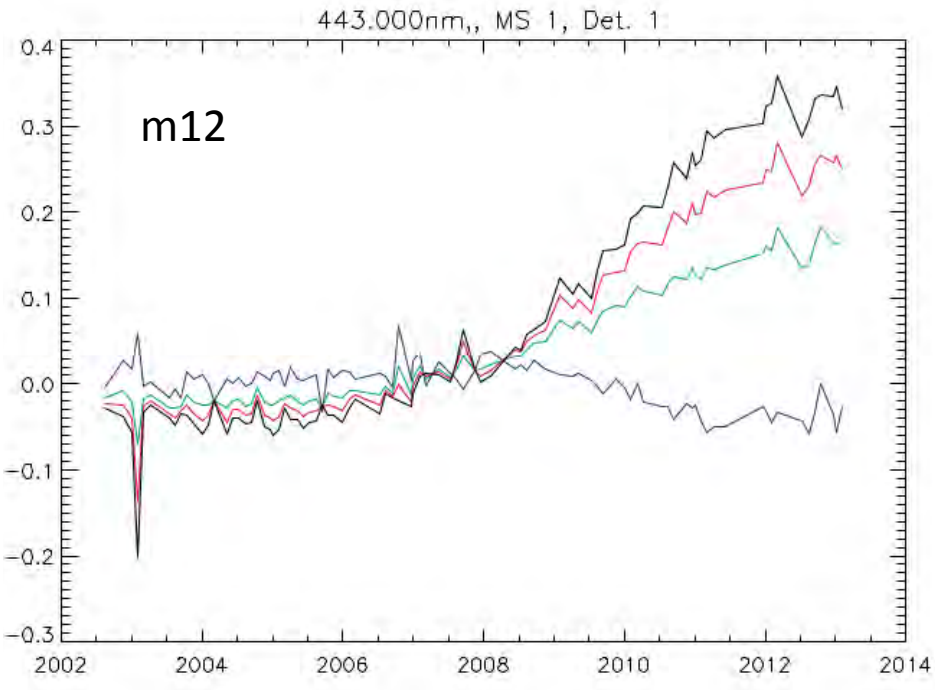
L_t: expected TOA radiance (from L3 Aqua)

Q, U : linear Stokes vector components, modeled from Rayleigh and glint

M_{11}, m_{12}, m_{13} : fitted instrument characterization parameters (depend on band, MS, detector, scan angle)

Cross-calibration of MODIST to MODISA: correction coefficients for 443nm

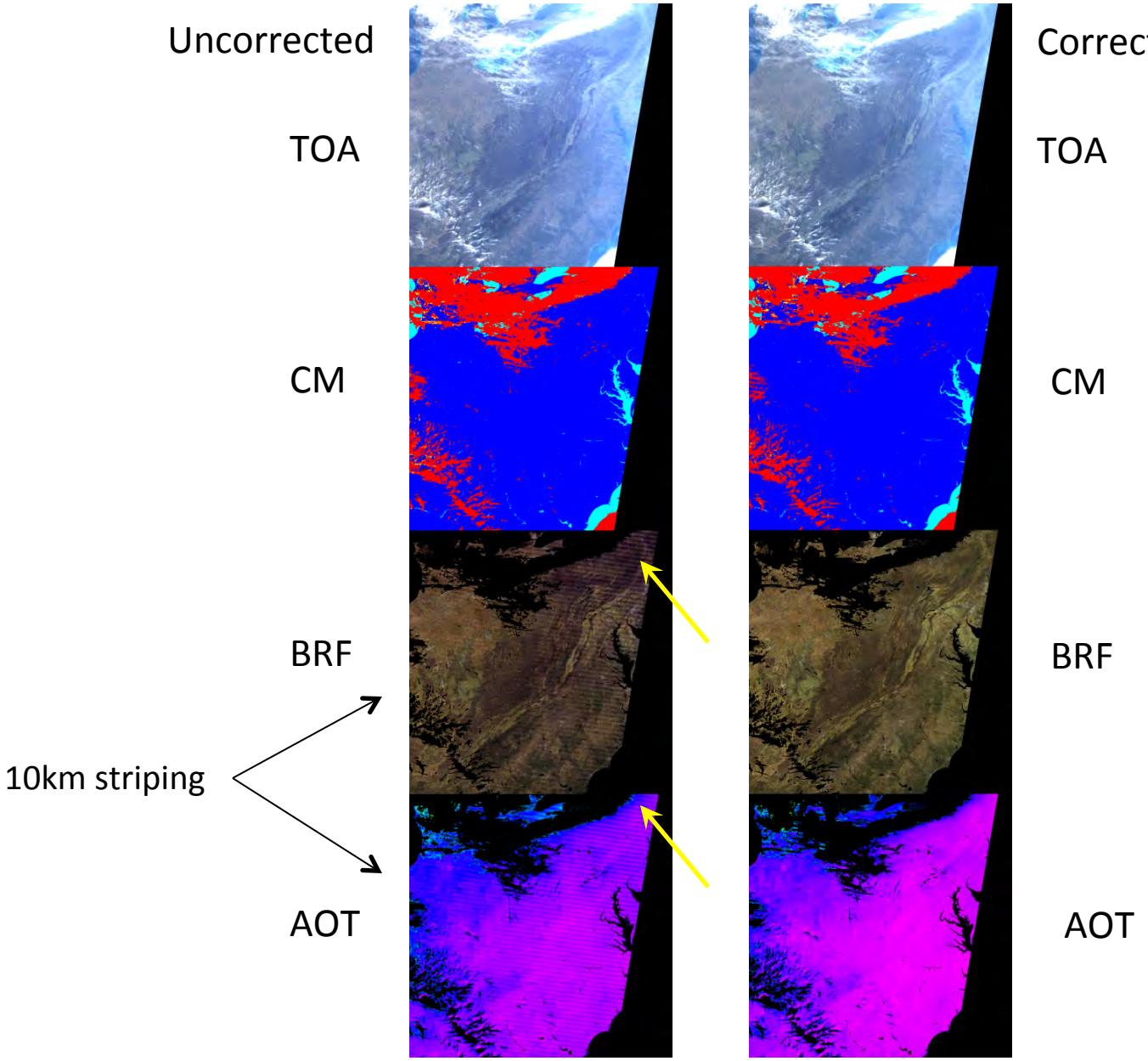




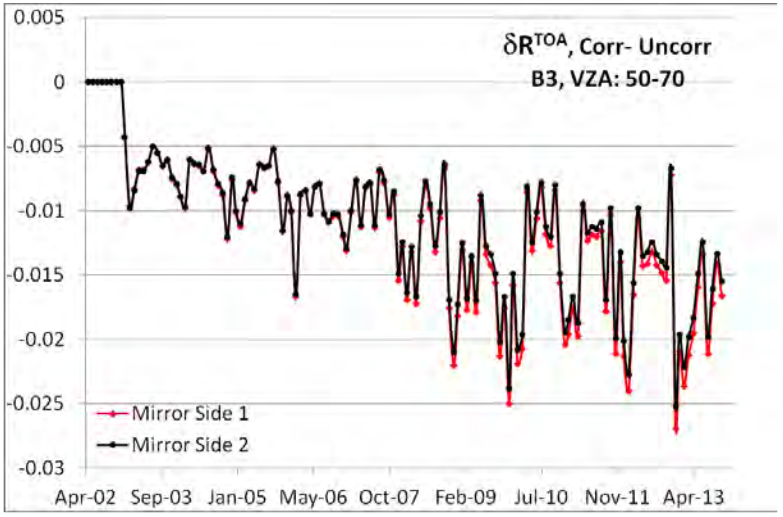
Scan angles (frame): lunar (22), nadir (675), Solar diffuser (989), end-of-scan (1250)

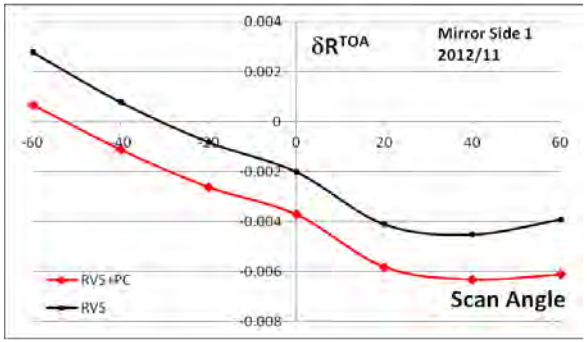
Polarization Correction: MAIAC Analysis

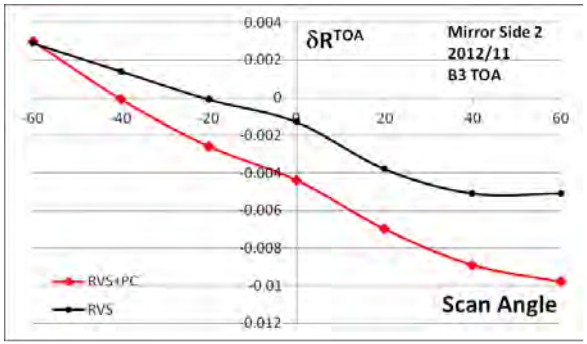
Right side of scan : improved AOT and SR (2012, DOY 349)



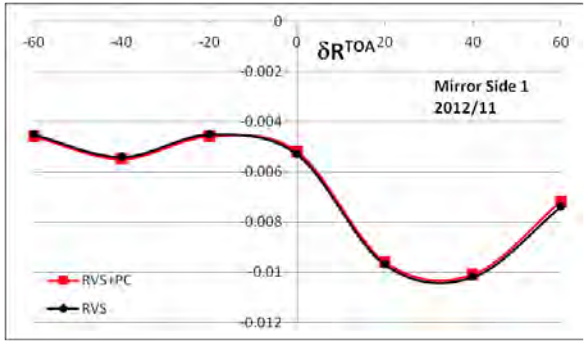
Polarization Correction: Detailed MAIAC Analysis (clear-sky pixels, monthly averages)

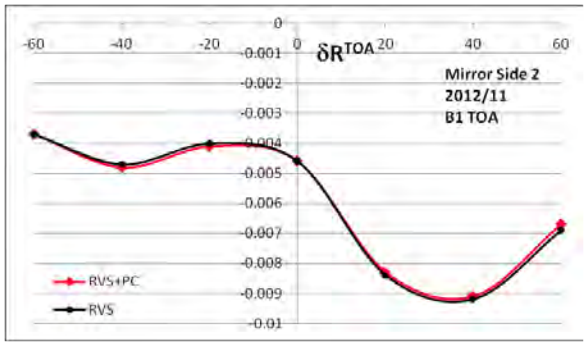






Partitioning between RVS and PC

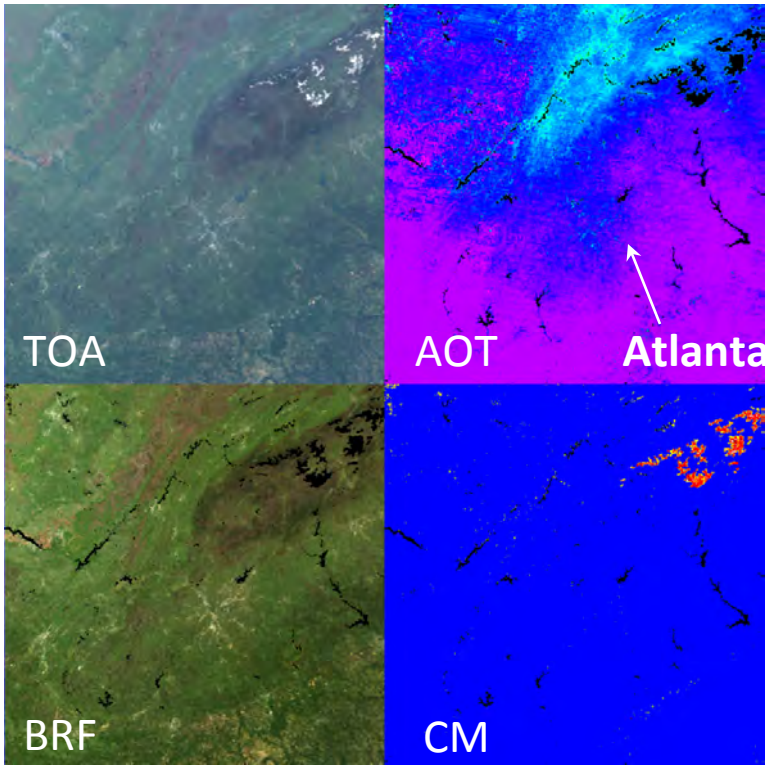


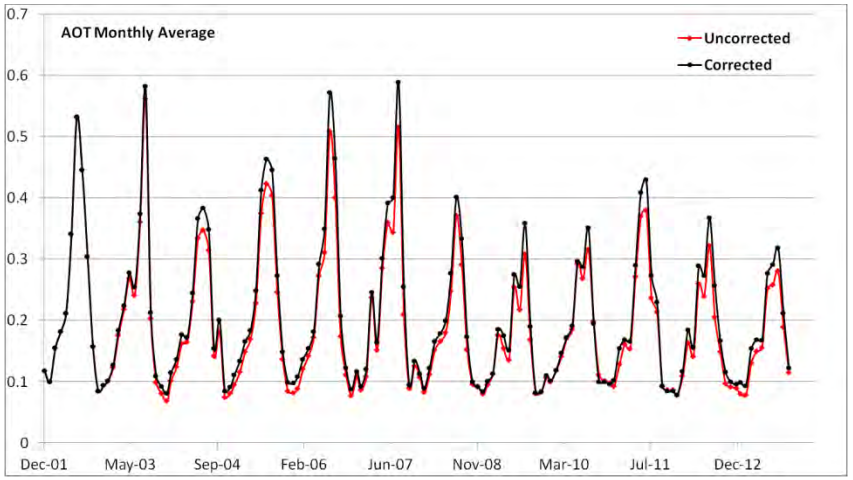


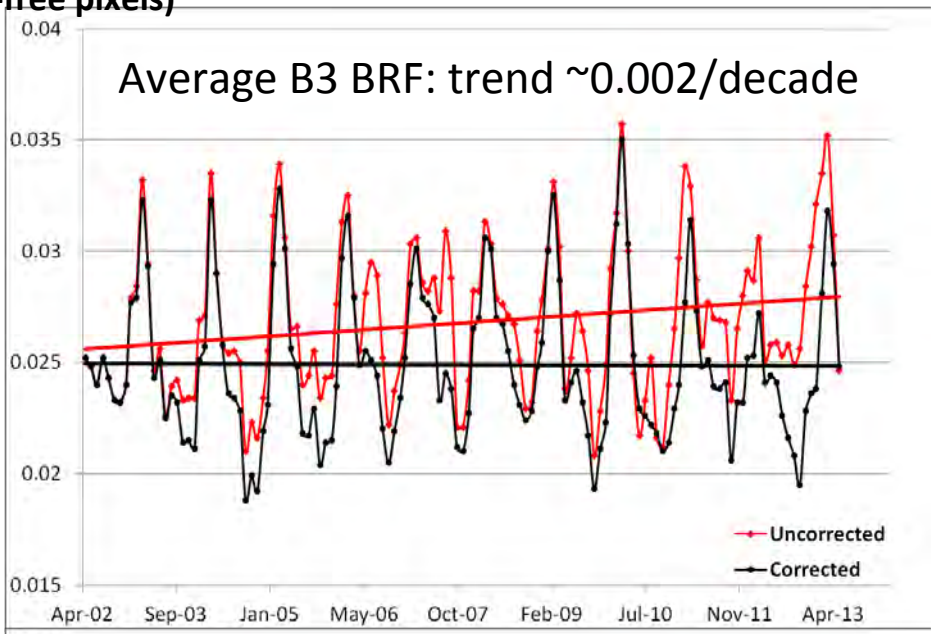
Bias Partitioning Between AOT and BRF in MAIAC

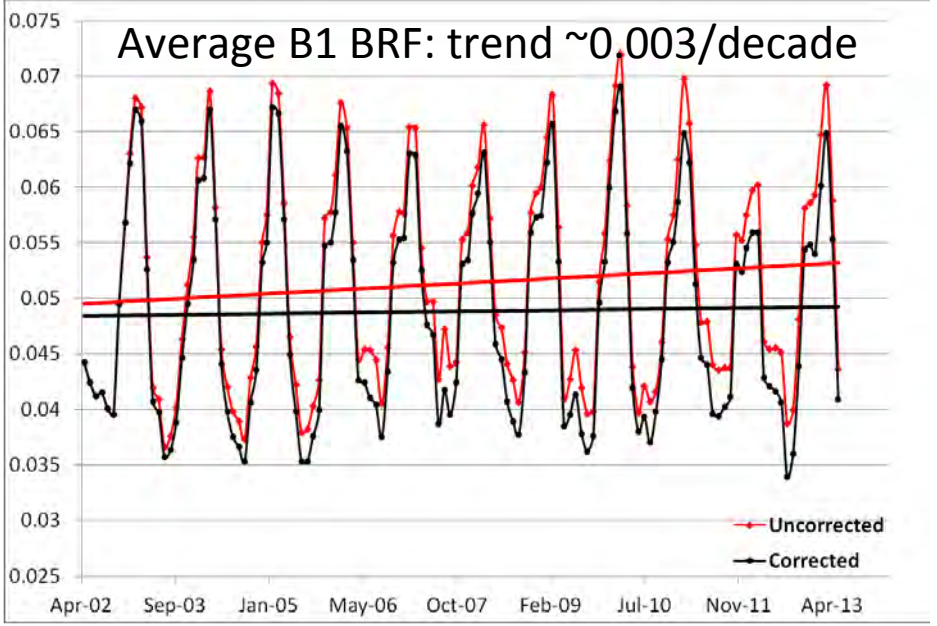
(cloud-free pixels)

April 12, 2003 (Georgia, 500km Tile)



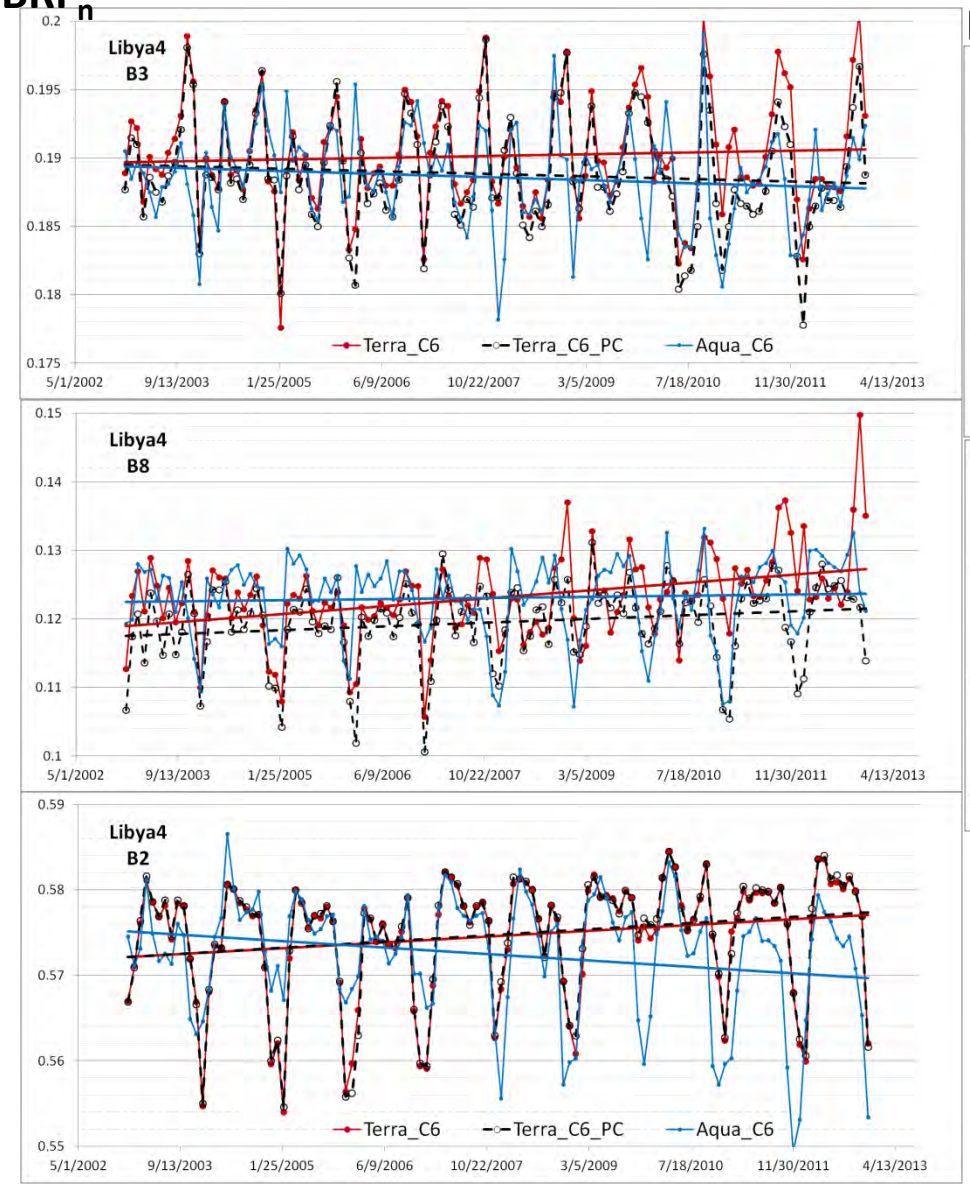






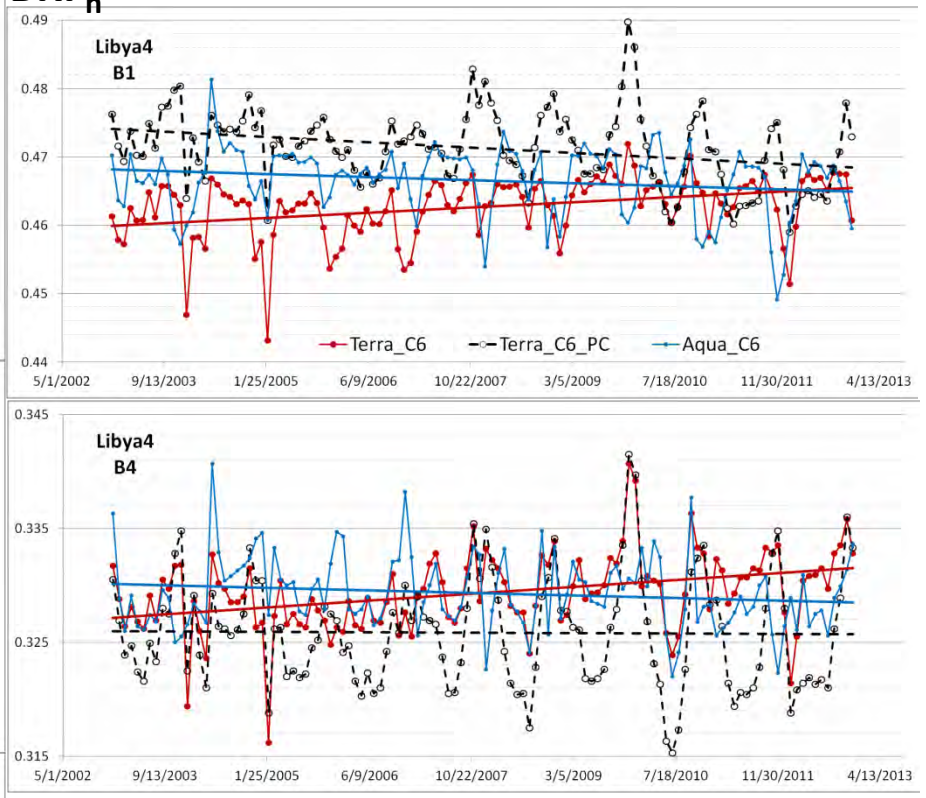
CEOS Desert Site Analysis: Monthly BRF_n

BRF_n



BRF_n

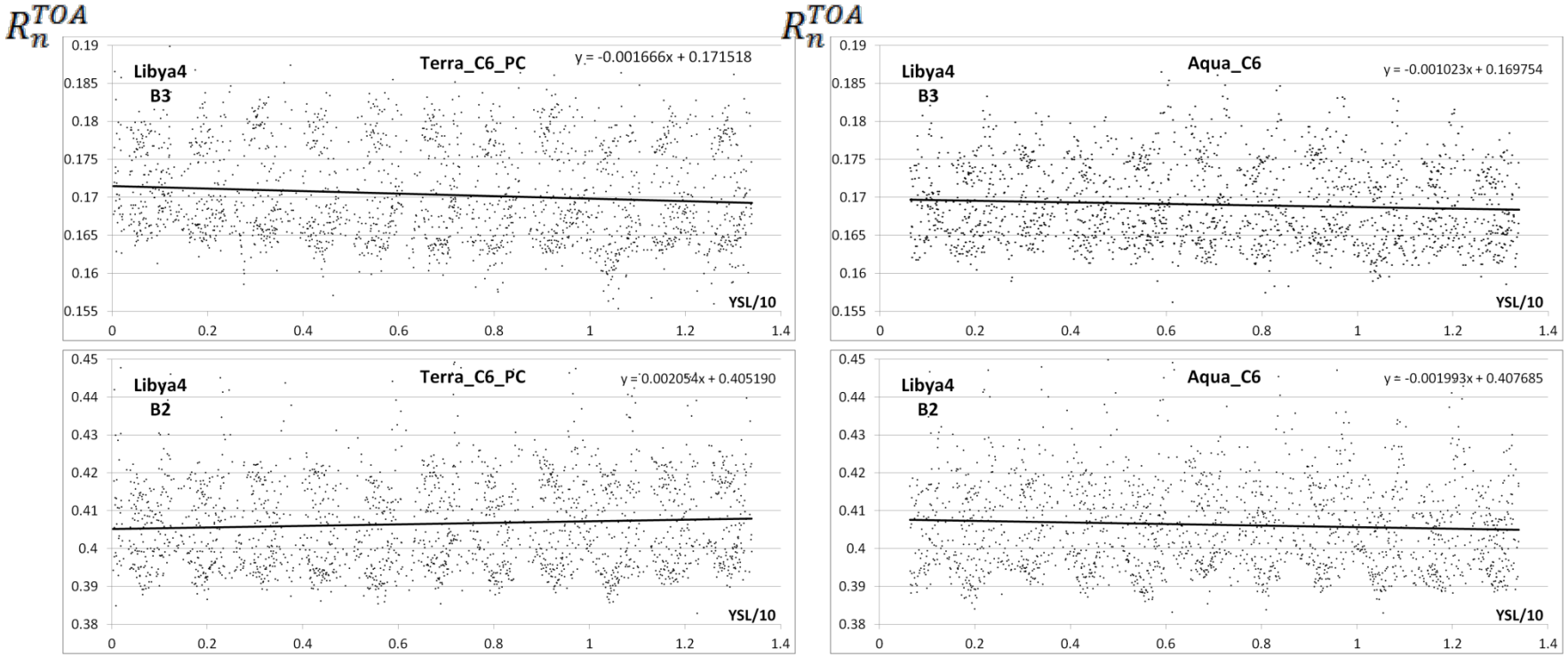
Libya-1, 13.35E, 24.42N



1. PC introduces artifacts in Red (B1) and Green (B4) bands. Decided to use PC for the "Blue" spectral region only (B3, B8-B10).
2. Small residual trend and T-A bias

MODIS de-trending and X-calibration

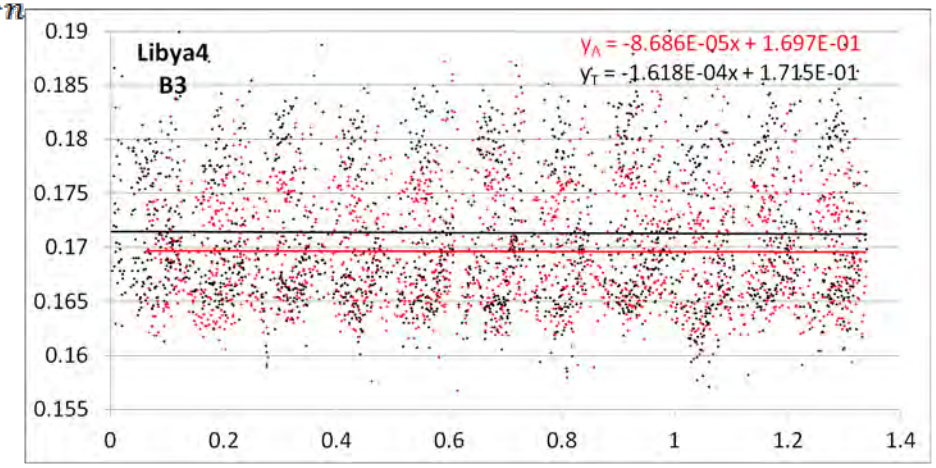
- Repeated trend analysis based on normalized daily TOA reflectances (R_n). Use of *daily* (vs *monthly*) values helps avoid sampling bias;
- The R_n (λ) were computed for fixed geometry (VZA=0°, SZA=45°) using MAIAC BRDF, WV, AOT. Normalization of geometry allows X-calibration between Terra and Aqua based on TOA radiance.
- Selected 4 sites (*Libya1*, *Libya2*, *Libya4*, *Egypt1 – thanks MODAPS!*) with similar trends. Three sites were excluded: *Niger* shows strong seasonality, and *Sudan1*, *Mali1* gave much larger and opposing trends.

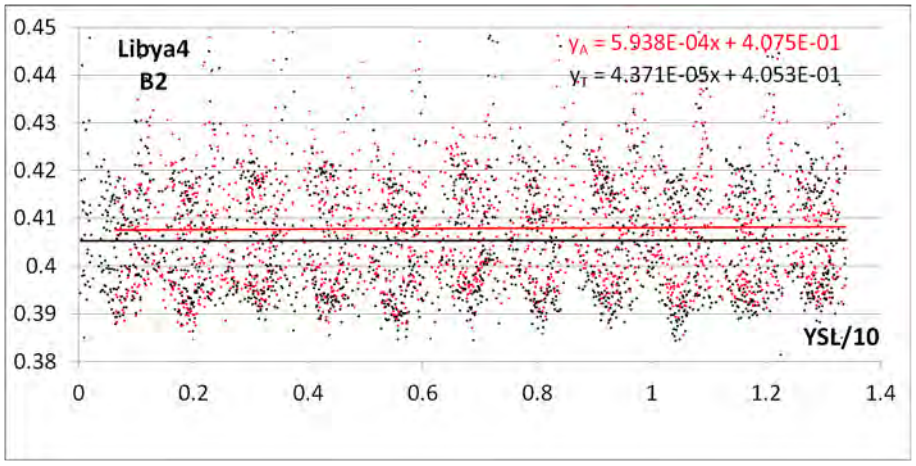


MODIS de-trending and X-calibration

- Obtained trends per unit of reflectance were averaged over 4 selected sites;
- The average de-trending was applied to Terra and Aqua giving new L1B.
- Normalized TOA reflectance were generated again for 4 sites. The final X-cal gain adjustment (for Terra) was obtained as an average over 4 sites.

R_n^{TOA}





Average trend/decade/unit_refl.

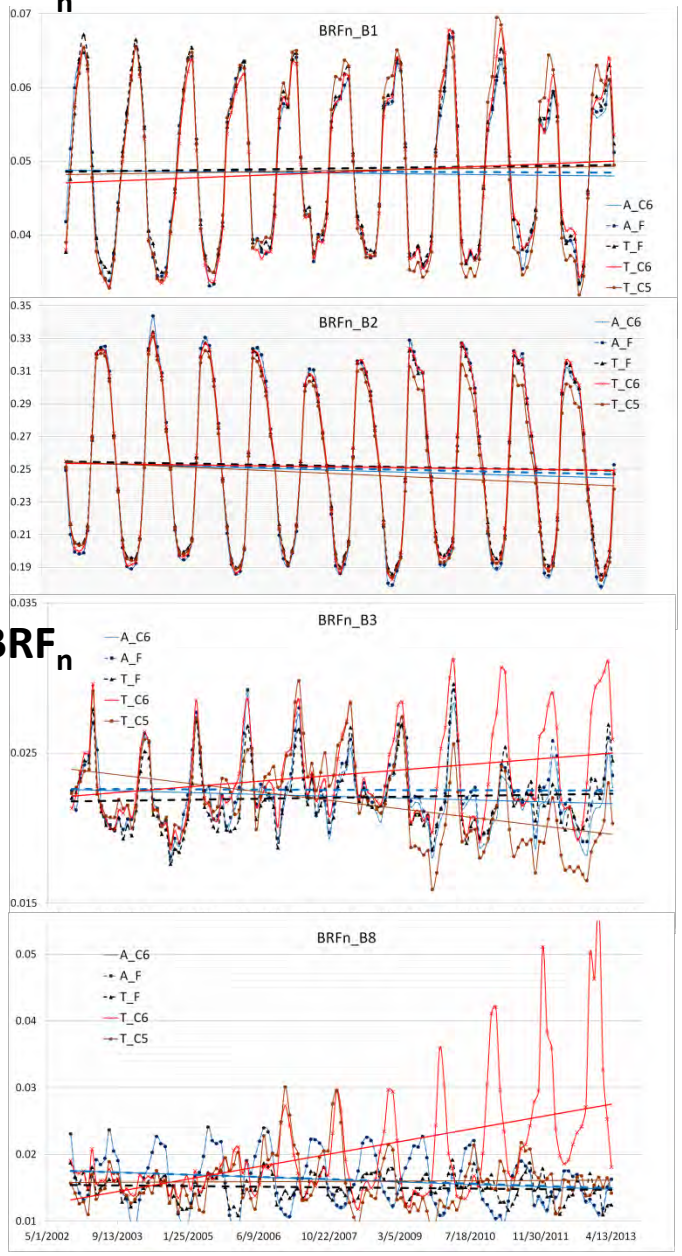
Bands	Δ_T	σ	Δ_A	σ
B1	0.0048	0.0020	-0.0046	0.0022
B2	0.0035	0.0019	-0.0062	0.0027
B3	-0.0082	0.0015	-0.0048	0.0016
B4	0.0049	0.0022	-0.0021	0.0023
B8	0.0094	0.0015	-0.0015	0.0013

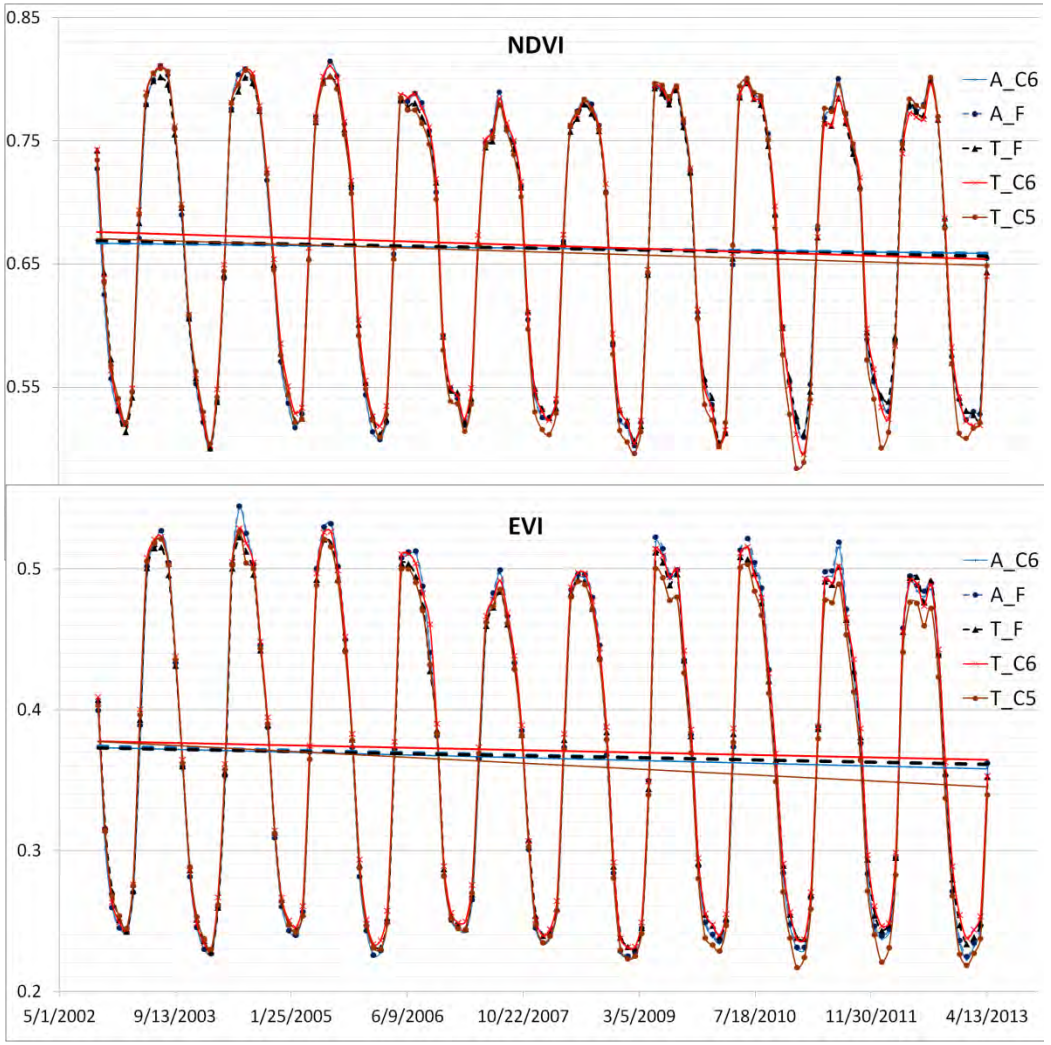
Average X-gain for Terra

Bands	Egypt1	Libya1	Libya2	Libya4	Xcal gain	σ
B1	1.017	1.023	1.021	1.019	1.020	0.0024
B2	1.004	1.008	1.007	1.006	1.006	0.0016
B3	0.989	0.992	0.992	0.990	0.991	0.0013
B4	1.006	1.013	1.010	1.009	1.009	0.0031
B8	0.997	0.996	0.998	0.994	0.996	0.0015

Final Analysis for Georgia: BRFn, NDVI, EVI

BRF_n





Version	ΔNDVI	ΔEVI
Terra_C5	-0.021	-0.032
Terra_Final	-0.012	-0.010
Aqua_Final	-0.008	-0.014

ΔNDVI=0.01 ~ 1 PgC

Summary

- Adapted OBPG PC for atmospheric/land processing;
- Developed de-trending and X-calibration technique based on desert sites analysis. This technique will be transferred to the calibration group;
- The L1B post-processing code (PC, de-trending, X-calibration gain factor) is provided to MODAPS group for global testing. The current consensus is the discipline-based implementation for C6 re-processing;

Final Considerations

- The remaining uncertainties from de-trending analysis are large (limited stats; non-uniform behavior over different “presumably stable” sites), yet proposed corrections cause changes in the right direction;
- Proposal: Prototype de-trending approach for Greenland ice sheet (e.g. Summit, 3.5km) where change is minimal and RGB signal much larger (expect at least a factor of 2 reduction in uncertainty);
- Changes are needed in L1B calibration (B3, B8): polarization correction should become a part of RVS-trending rather than a post-processing (J. Xiong).